

Ethical trust in the context of robot assisted surgery

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Abstract. Robot Surgery began as a general practice in the United States since 2000 when the robotic da Vinci Surgical System was approved for use in hospitals by the FDA. Recently there have been some questions regarding the safety record of these machines and their benefits relative to their expense. Should we as patients and caregivers place more or less trust in the technology of robotic surgery? To answer this question we will look at the possibility that robotic surgery may be an example of reverse adaptation, where the technology drives the social contract between the doctor and patient. Additionally we will look at the impacts robotic surgery will have on traditional aspects of the medical ethics of surgery such as informed consent, autonomy of surgeons and patients, corporate marketing, and the duty to provide the best available care, as well as increasing the asymmetry of the trust relationship between surgeon and patient. It will be argued that these issues will grow in importance as future robot surgery systems gain more autonomy in making or suggesting surgical strategies.

1 INTRODUCTION

In 2000 the US FDA approved the use of the da Vinci Surgical System for use in performing robotically assisted surgery. Today the use of this system has continued to grow at an impressive rate. Since its initial beginnings as a technological curiosity in 2000 to its wide acceptance as a cutting edge medical technology in 2013, it has been reported that 367,000 surgical procedures were facilitated by this system in the United States and 1.5 million worldwide [1, 2]. For certain kinds of surgeries this system is rapidly becoming the minimally invasive technology of choice with surgeons. Intuitive Surgical of Sunnyvale California claims that as of 2013 its da Vinci system is used in 27% of all Hysterectomies for benign conditions, and a staggering 87% of Prostatectomies [2]. This has helped lower the number of more risky open surgery procedures where large incisions must be done and the body of the patient opened up to allow traditional surgical techniques to take place.

The da Vinci system enjoys a near monopoly in the world of surgical robotics but there are more systems in development and competition is inevitable. Yet this system still sets the standard for robotic surgery as of the writing of this paper. It makes claim that:

The da Vinci Surgical System is a tool that utilizes advanced, robotic technologies to assist your surgeon with your operation. It does not act on its own and its movements are controlled by your surgeon. The da Vinci Surgical System has a 3D high definition (3D-HD) vision system, special instruments and computer software that allow your surgeon to operate with enhanced vision, precision, dexterity and control. The 3D-HD image can be magnified up to 10 times so your surgeon has a close-up view of the area he or she is operating on. The da Vinci instruments have mechanical wrists that bend and rotate to mimic the movements of the human wrist – allowing your surgeon to make small, precise movements inside your body. And, da Vinci software can minimize the effects of a surgeon's hand tremors on instrument movements [2].

This sounds like a wonderful addition to the tools of surgery but recently some safety concerns have been raised regarding this system. There have been questions of safety and questions of cost. Some studies argue that there are situations where the system is not any more risky than another type of surgery but that it is more expensive [3]. Others have reported that robotic surgery is not only more expensive but more dangerous to the patient [4]. There is also a report that made many news headlines that claims that hospitals regularly underreported injuries suffered by patients undergoing robotically assisted surgeries [1] [4] [5]. Shortly afterwards there was a raise in the number of safety issues reported by those hospitals using robotic surgery and this has prompted a new study by the FDA that is as yet unreleased [6].

These questions have deep legal and financial implications. Therefore it is best that we leave it up to large and careful institutions such as the FDA to fully analyse the claims made by both sides of the debate. We are not going to resolve the safety and cost debate here but we can add to the discussion by looking at the ethical issues raised by the effective marketing campaign mounted by the manufacturer and the hospitals that use robotic surgery systems. It is always best when law or policy is reflected by good ethical thought and that is what can be added to the discussion here. We will consider whether or not there has been an ethical breach of trust, which is somewhat different than a claim of legal fraud. Some have reported that the claims made by those selling this new and expensive form of surgery is motivated by commercial interests and oversold to the patients in need of hysterectomies [7] and robot assisted surgeries in general [8]. Even if it turns out to not be true that robotic

surgery is more dangerous, we still need to know if this technology has changed patient to doctor relationship and vice versa.

We are left with an important question as to what is the appropriate level of trust that patients, surgeons, and hospital administrators should place in this new device. If we are to trust this technology, then we have to be sure that this is not just another instance of an over hyped technology, to be sure, but there is another concern that is also important, yet it is one that is rarely noticed by those who are not researchers in the philosophy of technology, and that is whether or not this is another example of reverse adaptation to a new technology. Simply put, reverse adaptation occurs when we alter important social norms and situations to suit the limitations of a new technology, rather than forcing designers to make the technology more suitable to our lives before we begin mass use of the technology in question.

To get to an answer to these more ethical questions, we will review the special ethical concerns raised by surgery [9] [10] [11] [12]. Of particular interest from this literature is the question of how much informed consent is necessary when it comes to letting patients know that there is currently a debate going on as to the safety and cost of this kind of surgery. Since it is very hard for anyone to fully foresee the impacts of new information technologies, it is very common in the information technology world to release products that are not quite finished but once the users start complaining the devices are quickly upgraded. This strategy does not seem ethical in the medical context and are we letting the wow factor of high tech robotic surgery influence our decisions.

We also need to know if the special kind of professionalism that has emerged in the surgery profession is in jeopardy of eroding due to possible deskilling by robotic surgery. It is also important to realize that the rapid raise of robotic surgery is side-lining the development of other, more traditional alternative surgical techniques. Since these technologies are costly to buy for hospitals, they will not be available in most of the developing countries in the world that need to rely on more traditional surgical methods. Up until now there could be a fruitful exchange of ideas between surgeons in other parts of the world. We need to know if robotic surgery will increase the divide in technical knowledge and know-how to the detriment of developing nations. Even if it turns out that robotic surgery is safe and cost effective [13] [14], the ethical points raised above will still stand and a thorough ethical analysis of this technology is warranted.

2SURGERY ETHICS

Since robot assisted surgery is part of the vast territory of modern medical care, there will be much overlap of ethical concerns questioned in the existing literature of medical ethics. In order to focus our discussion, I want to pay close attention to how the specific technologies of robot assisted surgery effects the ethical decisions made in the practice of surgery. To achieve that end, I will list the questions in surgery ethics that I think are most affected by the technology in question, explain them briefly, and then move on to how these concerns might be impacted by the growth of robot assisted surgery.

In this paper I am primarily interested in the question of ethical trust. By that I mean that there is a significant

asymmetry in what the patient knows about the medical situation they find themselves in and what the surgeon believes would be the best treatment to mitigate the medical problem. The specialists that the patient hires to provide the medical care know much more and the patient has to trust that they will work in her best interest. A great deal of energy is spent by the medical establishment in maintaining its status sociologically as trustworthy members of the community that one can be confident in handing themselves over to for care. Surgery is a special case in medical care that demands even more trust from the patient since the patient in a serious operation has placed their life almost literally in the hands of the surgeon [10].

When it comes to surgical procedures there are some specific questions of trust that the patient has the ethical and in most cases also a legal, right to be confident of before proceeding with the surgery that the specialists recommend.¹

While surgery is a very ancient practice, surgery ethics is a surprisingly new discipline. Peter Angelos has said that, "While 20 years ago, the concept of surgical ethics was thought by many to be an oxymoron, today there is increasing exploration of ethical issues central to surgery in surgical journals [10]."

In their article "Ethics in Surgery," Anji Wall, et al. argue that while much of bio and medical ethics applies to surgery, it does so in ways that are different from other medical practices, "...in clinical medical ethics, although principles such as autonomy and non-maleficence are distinctly prominent for both medical ethics and surgical ethics, they do not map on to one another exactly [16]." We will address some of those differences now.

The major difference, as was mentioned earlier, is that there is a great deal of physical intimacy involved in the surgeon patient relationship that is quite unique given that the surgeon operates literally inside the body of the patient, placing the patient in a radically vulnerable position [10]. The philosopher Rom Harré in his book "Physical Being," maintains that the human body, "...is and object whose value is routinely recognized in the ways it is accorded the protection that pertains to those entities a culture takes to be sacred [17]. While not to suggest that modern surgeons make too much of this, but the former statement might suggest that there is at least the hint of something of the sacred in the relationship between the surgeon and her patient. Since people are not things, the surgeon has to perform a special kind of mental ritual where the patient goes from fellow person, to the anesthetized, unconscious body-as-mechanism in the operating theatre, back to a fully functioning person. That is assuming all goes well. This is a curious relationship that is not common outside of the surgeon patient relationship. One more philosophical point that will underlie my arguments rests on my commitment to a form of embodied morality. This might best be described by Lakoff and Johnson who state very succinctly that:

Our concepts of what is moral, like all our other concepts, originate from the specific nature of human embodied experience [18].

Since morality, under this view, emerges from our embodiment and the possible interactions with each other and our world that our body affords, it follows that surgical altering of the body is a fundamentally ethically charged action that carries

¹In everything that follows it will be assumed that the patient is a fully rational adult. I acknowledge that ethical reasoning can get much more complicated when the patient is not an adult or is an adult but has some form of mental deficit from which they suffer.

with is a very high standard of personal responsibility for the surgeon in insuring a good outcome of the operation [16]. It is astounding that this fact was not seen in earlier ethical thought, but it is now and it must be taken seriously.

Anji Wall, et al. describes a number of ethical issues that are specific to surgery such as; surgical informed consent, industry relationships, and outcomes reporting [16]. They also inform us that there is a distinct difference in the way in which trust has to develop between surgeons and patients. The relationship, while much more intimate than that with a primary care physician, is also much shorter, so there is a rushed timeframe in which the surgeon must gain the trust and informed consent of the patient [16]. Industry relations are another tricky ethical point that will be particularly telling in the discussions later in this paper. While it can be successfully argued that there should be a separation of industry concerns from medical care in general practice, in surgery this is more difficult to maintain. Surgery is a technology and its innovations are technically mediated. Surgeons need industry to finance the innovations and the industry needs surgeons to propose the innovations and test them when they are built since surgeons are the only ones that have the authority to use these technologies on live humans [16]. "An ethics is needed surrounding the collaborative effort between surgeons and industry, which recognizes the necessity of this relationship as well as the potential for significant COI [conflict of interest] [16]." Outcomes reporting are also easy to do with surgical procedures since the causes and effects of actions done in surgery are far less mysterious than they are with drug reactions for example [16]. As we saw in the introduction, this ease of outcomes reporting has been a double edged sword in the case of robotic surgery, as both sides, pro and con, argue over the meaning of the outcomes that have been reported in various forms of robotic surgery.

Nada Gligorov working with surgery faculty and surgery clerkship interns at Mount Sinai School of Medicine in New York worked on a two year project to identify ethical dilemmas particular to surgery [11]. They came up with a wide variety of specific cases such as; if a surgeon discovers a dangerous tumour while they are operating for some other condition, is it ethical to remove the tumour without the patient's consent. From the various cases they concluded that there are three broad categories that the majority of the cases they found can be fit into:

- (1) the scope of informed consent, (2) truth telling with respect to the occurrence and disclosure of medical errors or the role of learners, and (3) decisional capacity [11].

All of these make some background assumptions in ethical theory that Peter Angelos describes as, "the four widely known ethical principles of respect for autonomy, beneficence, non-maleficence, and justice as the prism through which to consider surgical complications [19]."

Informed consent includes specific ethical concerns such as paternalism, respect for the autonomy of the patient, surrogacy in patient advocacy, and the beneficence of proposed surgical procedures. Since the patient is often not conscious during surgery, the patient must trust that the decisions made on her behalf during the procedure will be done with her best interest in mind [16].

Truth telling mostly focused on the necessity to report medical errors such as; "...iatrogenic injury and errors in

diagnosis, erroneous administration of drugs and other medications, technical errors during surgical procedures, and errors in interpretation of laboratory findings" [11]. Some of the specific ethical questions that they found in informed consent, such as autonomy and beneficence reappear here and non-maleficence could be added as well, but there is also an interesting new ethical mandate; fiduciary responsibility. Fiduciary responsibility is the ethical mandate that the surgeon place the interests of her patient before her own. Gligorov, et al., argue that since the patient has placed so much trust and control of their body into the surgeon's hands, the surgeon has a moral obligation to honour that trust and to use that power to only further the interests of the surgeon or the institution she belongs to would be a gross breach of that trust. "Thus, a physician may not conceal or refrain from disclosing a medical error in hopes of avoiding a lawsuit or unpleasant emotions and embarrassment [11]".

Decisional capacity is, of course, related to informed consent but is a bit more specific in that it insists that the ability or "capacity" of the patient to make independent decisions about their own healthcare, such as informed consent of the patient to participate in a study, is of a sufficiently high level to warrant it an autonomous decision made in the patient's self-interest. An interesting wrinkle here is that Gligorov, et al., remind us that patients might display inadequacy in their own ethical decision making, for instance selfishly demanding that only the best surgeon be allowed to work on them, and that these decisions do not have to be honoured [11].

One additional aspect of surgery ethics that I will want to make further reference to is professionalism and the demand that surgeons all display excellence in the skills necessary for their profession. Peter Angelos has argued that "...Perhaps nowhere in medicine more than surgery is the influence of role models more important [10]. This apprenticeship model is important to remember when thinking about surgery ethics because it means that concepts from virtue ethics and the ethics of individual character will be of particular value in the rest of our discussion. I also bring up the point of professionalism in surgery specifically because there has been some discussion that technologies such as robotics are diminishing the ability of new medical professionals to develop the skills necessary for their job, for instance, will robot surgery devices eventually replace humans or otherwise diminish the role that human surgeons now play [20].

The above discussion is not meant to be exhaustive since others have already accomplished that task, see [16]. There are many other ethical issues that relate to the professional life of a surgeon that we will not need to cover here since they are not directly impacted by robotic surgery technologies. But now that we have reminded ourselves of the most philosophically interesting questions in surgical ethics that have a bearing on robotic surgery, let us now look at the ways in which robotic technologies have, or may, affect how we reason about surgical ethics.

3 INNOVATIONS IN SURGERY AND ROBOETHICS

Surgery is a medical practice that very closely links technologies, sciences, and social practices. In the literature of the philosophy of technology and science studies, this kind of

complex system is often referred to as a *technoscience*. With the readers indulgence, I will use this term, but by doing so I am making only a modest claim that technology, science and society are interrelated in mutually supporting ways, not the stronger claim that science and technology are determined only by culture, which is a view one might read in the works where the word “technoscience” was coined of Bruno Latour and his school of thought. I am hijacking the word here, as I do on many occasions, for my own purposes. In a technoscience, innovations can be initiated from scientific discovery, technological change, and/or societal² needs. The innovations found in robotic surgery find their origins in complex mixtures of these three catalysers for change.

Even though innovations come from these largely impersonal forces, there is a distinct role for ethical reasoning when surgeons attempt to place controls on adopting new innovations. In their article “The ethical challenge of surgical innovation,” Paulo Palma and Tomas Rosenbaum start their article off with an important quote, “there is no control on surgical innovation outside of the realm of the surgeon's own ethical and moral compass,”³ but these ethical deliberations are never simple [21].

The literature on the ethical impacts of surgery innovation is somewhat sparse but there has been some quality thought put into it and the following factors have been identified as important considerations for surgeons considering the use of innovative surgical techniques and technologies.

Foremost, it is important to remember that:

Ethical dilemmas always appear when new devices developed in the laboratory are transferred to the bedside. Regulatory agencies such as the Food and Drug Administration in United States are more flexible with new devices than with drugs [21].

This means that surgical innovations are approved relatively easily for use, sometimes with no clinical trial at all [21]. This means that surgeons cannot just rely on governmental agencies or even academic or institutional review boards to always make the right decisions ethically before a new innovation is introduced into surgical practice [21] [22]. This tendency grows out of the special history of surgical innovation where many techniques simply occurred to the surgeon while an operation was underway and then communicated to her peers for discussion later. This tolerance for individual innovation has greatly advanced the technology of surgical procedures. Interestingly enough, the introduction of robotics to surgery has not been marked by this wide open experimental process, since it is an innovation that comes from outside the surgical establishment; it has had to deal with more regulations than other surgical innovations [23]. We will look at that in a little more detail in the next section of the paper.

In addition to the ethical concerns raised by surgery in general that we looked at in the last section of the paper, there are a number of ethical qualifications that must be addressed when looking at surgical innovations such as surgery robots.

Innovation in surgery has always been motivated by the wish to decrease morbidity and mortality in the patient outcomes of surgical procedures. But in modern times this is not the only motivator, sometimes the innovation is for cosmetic reasons. For instance, a traditional thyroidectomy has a high chance of success and a high 20-year survival rate but leaves the patient with a large scar at the bottom of their neck. Robotic assisted transaxillary thyroidectomy is a high tech innovation that allows the surgeon to do the operation through a n opening further down the chest leaving a scar that is easier for the patient to live with, though it is hard to tell if that procedure is ethically better than the traditional surgery as the twenty year survival rate is believed to be unaffected but is yet unknown and there may be small increases in serious and life threatening complications from mistakes made in this procedure [9] [22]. The reason for this innovation is not simply because surgeons thought it was better than the traditional procedure since in fact it might be marginally worse in terms of complications and increased chance of mortality. Instead this innovation is more likely motivated by technological possibilities afforded by advancements in robotics, manufacturers looking for a way to market their robotics technologies, and patients wanting a more minimally invasive procedure with a beneficial cosmetic outcome.

Informed consent is also exacerbated when it comes to innovations since both the patient and the surgeon will be susceptible to the natural human inclination to equate the newness of a technology with the idea that it is also a significant improvement over the old procedures, and this can be exacerbated by the optimism bias of the surgeon who may be involved in the design of the new system [22].

There is often a steep learning curve involved in innovation [9] [21] [22], and this has been particularly true of surgery robotics [23]. This can lead to an inability of the surgeon to fully inform the patient of potential risks since her inexperience with the technology would cause her not to know what they are and the novelty of the machine might mean the makers of the system don't even know all the potential risks.

New innovations are expensive and surgery robotics is no exception. For a hospital to buy a robot assisted surgery device like the da Vinci Surgical System will cost well beyond a million US Dollars and that is just to get it in the door as it will also require continued maintenance and tech support. Also, innovations may increase the time a surgery takes in the operating room, though this might also be offset by faster patient recovery times for more minimally invasive surgeries afforded by the long arms and small actuators, lights, and cameras that robots have which can fit into very small incisions in the patient's body.

As we saw earlier, conflict of interest is a problem here [16] since the robotics industry cannot design these robots without input from surgeons, but this may make these surgeons less capable of properly critiquing the innovations they are financially or academically benefiting from.

Pete Angelos has suggested that it will be difficult to regulate this from the outside and this is painfully evident in the recent debate over the da Vinci Surgical System where the FDA I shaving a difficult time accurately adjudicating if there is even a problem for them to investigate or not [6]. This means that the primary locus for ethical debate must be led by surgeons

²Note that by society I mean not only the public outside of professional surgeons but the social groups both professional and informal that surgeons themselves form.

³Quotation from: Reiter-Theil S, GJ Agich (2006) Research on clinical ethics and consultation. Introduction to the theme. Med health care Philo 1:3–5

themselves with significant input from ethicists, professional societies, patients, and patient advocates.

Before we end our discussion in this section, we should look briefly at roboethics. Roboethics is a new discipline that seeks to discover the most ethical ways to add robotics and agent based technologies into various aspects of our lives. Since robots are designed to do things that humans otherwise would have, this technology is particularly ethically charged. Of course defining what a robot is that other technologies are not is a technically and philosophically challenging task [23], but let's just be pragmatic here and simply define a surgical robot as a medical device designed to perform an action that traditional surgical tools need a human (either a surgeon or an assistant) to perform in the past. So a scalpel is not a robot, but a machine that manipulates a scalpel blade either on its own or under the transduced movements of a surgeon is a robot.⁴

Even though the concept of robot is a shifting term that has evolved to include much more than the imaginary humanoid machines it originally was coined to refer to, there are some concrete ethical concerns that robots of any shape give rise to.

The first is what I and others have referred to as "distancing," which is the tendency for human operators to experience changes in their ethical commitments to other humans based on the technological mediation of the interaction provided by the robot. We will see that this may play a role in altering the surgeon-patient relationship as it becomes mediated through the surgical robot. The second is a kind of ethical confusion where the users of a system mistakenly purport more ethical agency to the system than it actually has. And the third that we need to talk about here is that these systems, like many other technical innovations, can cause reverse adaptation, where the social system that the machine is inserted into alters to fit the needs of the machine rather than the other way around. Finally, robotic systems are attempts to make technology more autonomous and proactive in solving our problems. Thus they always have at least a little AI programming and we are likely to see more and more added to these systems as advances in AI are forthcoming. This means that eventually a line may be crossed where the machine has a startlingly high level of autonomy and agency, in which case roboethics will need to help describe how to program these machines to make ethical choices. The moral of this story is that robots either influence human ethical decisions, or in more advanced cases, must be capable of making those decisions themselves.

When it comes to robots used in surgery, even now we have machines all along the spectrum of autonomy. Camarillo, et al, in their historical overview of surgery robots show that as of now we have some machines such as CT scanners that are almost fully autonomous, whereas telesurgical devices such as the da Vinci surgery system is not very autonomous at all. Conversely, the CT scanner has little direct contact with the patient whereas the da Vinci is very active through the surgical process [23]. Thus we see that when an action is safe and routine, it can be more readily automated but if the surgical action is risky and requires a lot of cognitive skill to perform, the machine must be far less automated. Machines in the

middle of this spread are things like AESOP that the surgeon controls with voice commands and the machine autonomously provided imaging that the surgeon can use during the surgery [23]. Another example is RoboDoc, which the surgeon can program to mill bone somewhat autonomously during an operation while she attends to other things, this works since the reaction of bone is predictable and relatively free of complications [23]. In the future we might see machines that are both autonomous and directly active in making surgical decisions. We are some years away from that right now.

4 ETHICAL TRUST BETWEEN PATIENT AND ROBOT SURGEON

We now have enough background to approach the question that I started this paper with, should we as patients and caregivers place more or less trust in the technology of robotic surgery? That answer will be found in how much robotic technoscience has modified the traditional relationship between the surgeon and her patient.

The first issue is distancing. Aimee van Wynsberhe and Christ Gastmans have addressed this in their ethical appraisal of telesurgery in the context of an ethics of care [24]. In their analysis, it is most important that the system does not reduce the patient to simply an object being operated on. They also find that there have been some significant benefits for both patients and surgeons with telesurgery given that the systems allow patients to have the benefits of minimally invasive surgery, while the surgeons get a system that is more ergonomically comfortable for them to do the procedure with and:

The robotic interface is subsumed in the caring work of the physician and re-integrates the element of attentiveness of the surgeon. Thus, the phases of caregiving and care-taking are enhanced [24].

At this time there are few distant telesurgeries that are done with the surgeon at a great distance from the surgery. In the da Vinci system, the surgeon is seated at a console just a few feet from the surgery, but there is no reason that this distance can't be increased to thousands of miles to distant battlefields, deep ocean or even space, in fact NASA and others have been working on this capability for some time [25]. There are also many forms of telesurgery from a remote surgeon consulting with a local surgeon, or the remote surgeon mentoring the local surgeon through a novel process, to the remote surgeon assisting in the operation or even taking over and doing the entire procedure remotely. Each of these has a different ethical dimension, the further the surgeon is from the procedure she is doing, the less likely that the surgeon can develop a human connection to the patient. But as long as there is a human locally present, they can take on that role and we can tolerate the dehumanizing nature of the remote surgery [24]. But we also have to remember that if it is a choice between remote surgery and nothing such as in a battlefield situation, then the niceties of human care will have to be lost in order to gain the good of saving a life.

A technical issue is that the system will experience latency at greater levels the further one gets from the surgeon [25]. This would mean that it might be risky to trust such a system to be operating in one's best interest but again, this might have to be tolerated if it is the only option and the patient needs an appendix removed on her way to Mars.

⁴I realize that that commits me to some possibly strange extrapolations, such as having to say that an aircraft that is flown entirely by wire or remote control is a robot, but I am fine with that charge if you want to level it on me.

We also must acknowledge that ethical distancing, in the case of surgery, might actually be beneficial. A surgeon actually does her job better when they can compartmentalize their view of the human they are working on as a fellow person. In normal situations in most cultures it is considered quite rude to carve on another person with a knife, therefore we need to have a situation where the personhood of the patient is set aside just a bit while the operation is underway but returned quickly when it is over [17]. So a mixed system where there are humans who are tasked with caring for the patient and treating her like a person after the surgery will help make distant telesurgery with robotic systems tolerably ethical and maximise informed consent and ethical trust between the surgeons and their patients.

When it comes to surgery robots we have a different situation than what is found in care robots commonly. Care robots are designed to make the patient feel just by looking at the machine that it cares for them. I am thinking of machines like *Paro*, the companion robot.⁵ These machines can make the patient feel that there is a real caring agent there behind the robot's eyes when there most likely isn't. When it comes to surgical robots, these things all tend to look like futuristic torture devices and may actually elicit just the opposite reaction from patients who might find them frightful or more dangerous than they actually are. The design of these machines is dictated by function and little effort is placed in making them look friendly. The only personal experience I have had with medical robots was a CT scan and that was a little emotionally disturbing due to the confined space and loud noises the machine made, and I only kept my sanity by listening to the human voice of the technician who talked me through the episode. We can see that this affects the conditions under which informed consent are sought and on the loss of autonomy that these systems require from the patient.

Finally we need to address the charge of reverse adaptation. If it is true that robotic surgery devices are being pushed by industry in ways that are unwelcome by surgeons and their patients, then there would be few good reasons to trust this technology. More subtly, this technology may slowly alter the technoscience of surgery, where incremental changes add up over time to a system that is not the most ethical system one would hope for.

As we saw in the introduction, there are surgeons that are questioning the rapid growth of the use of the *da Vinci* surgical system claiming that the robotic surgery is more expensive, takes more time and produces no significant benefits [3] [26], while others argue that injuries and complications from the system are under reported [1] [4][5], or that the systems are over hyped, [8]. But the system also has some vocal defenders that claim it is too early to tell but it has promise for some procedures [27], or that the system is clearly beneficial, [14] [28].

The extent of this debate leads me to conclude that for now one should think very carefully about allowing one's surgeon to use a robotic surgery device. It does not look like there is a conspiracy to hide the truth about injuries and complications created by using robots in surgery, but it also looks like there is some confusion in exactly what the right rates of injury are. These systems are still new and that means you are part of the testing. There are some procedures that clearly benefit from the use of robotics but others that are not, the patient needs to make

sure she is a good self-advocate and does not allow the optimism bias of her surgeon overly influence her decision. It is just an unavoidable problem that informed consent is going to be more difficult and situational decision with this technology.

It is also clear that a lot of marketing is going into the sales of these machines and there will be a bit of over prescription and reverse adaptation due to hospitals having these expensive machines and therefore wanting to use them. That in no way implies that there are not many legitimate cases where they are the right choice, but it does mean that it is possible to be misled so there has not been a conspiratorial ethical breach of trust, nevertheless when it comes to robot surgery—trust but verify.

5 ROBOT SURGERY AND PROFESSIONALISM

Our discussion of reverse adaptation leads naturally to the question of how these technologies will change the profession of surgery.

Mark Coeckelbergh has written about the effect information technologies has had on the profession of healthcare, some of which applies to our topic at hand [29]. His, starting point is an idea taken from virtue ethics where good work is seen as something more than just technical efficiency but also quality driven and ethical [29]. The ethical situation created by good work is experienced both by the agent and the patient, the patient receives good humane care and the agent is made a better, more virtuous person through the process. The agent develops a practical wisdom from doing good so that through the experience of doing quality work, she becomes more able to make correct ethical judgements in future situations.

Ethics should not be understood as something external that is or should be imposed on the practice; this usually does not work and is rightly resisted by professionals of all sorts. The marriage of moral and professional excellence is an internal matter: developing moral and professional skills is internal to developing oneself as a (care) worker [29].

That is what we would hope to achieve but it is possible to design technoscientific systems that impede this process. For instance a robotic surgery system where a remote surgeon worked on patients in distant locations one after another and there were no mitigations present for her to ever see the results of the beneficial actions her work was creating. Or, if the systems became more autonomous and allowed the surgeon to become deskilled, then professionalism and excellence would be diminished and with it the ethical value of the work done.

One might make the counter-point that who cares if the surgeon is denied a chance to become excellent at surgery if the machine that replaced her provided a better outcome? Coeckelbergh argues that arguments like this are missing the point, better means ethical, so you would have to show that the technologies that replace the surgeon produce not only good technical results but also better social and ethical outcomes as well, if you can't do this then the technical system is not really better [29].

Coeckelbergh is not arguing that all technological advances are by necessity deskilling and corrosive of professionalism. He contends that it would be possible that while the machine might take some of the necessity for learning technical skills from the caregiver, it will then give that person the time she needs to

⁵ <http://www.parorobots.com/>

further develop her interpersonal care giving skills [29]. The job of future surgery professionals then might not be to be as active as they are now in the surgery, but as human guides that help the patient navigate the somewhat impersonal and technological process that robot surgery is. It is only another human that will experience the appropriate amount of worry and care that goes into contemplating something as drastic as surgery. The robot does not have the capacity to care if the patient lives or dies; it is only the human operators that bear this burden.

It is not uncommon for a surgeon to stay up late thinking about a difficult upcoming operation. In fact, when most people think about the risks and burdens of surgery, they tend to focus solely on the patient. However, the toll of operating in complex cases where the risk of complications is great should not be underestimated [30].

Even with great advances in the autonomy of robotic surgery, until machines become conscious, there will always be a role for the human care professional in surgery. As was mentioned earlier, surgery is a profession where role models play a vital role [10]. This means that future surgeons will need to focus more and more on providing good role models for making moral choices and advocating for patients, since this may become their primary duties in a future of robotic surgery.

One last point is that while the technologically advanced nations put a lot of effort and money into robotic surgery we should note one very large undelivered promise. Telesurgery was initially proposed as a way to give better care to the far flung locations of this world where people do not have access to quality surgical care. Unfortunately the lack of standardization in communications technologies between nations and the digital divide between the technological capabilities of the industrial world with those who still lag behind means that telesurgical technologies are not of any use to the developing world [24]. Surgical innovations that rely on high technology do not transfer well to the rest of the world and our selfish drive to create this technology for our own use can be seen as unethical when we could be putting that energy into developing more traditional techniques that can be easily adopted in other locations [9] [22].

7 CONCLUSIONS AND FUTURE CONCERNS

After this discussion we are left with a cautious optimism for the technoscience of robotic surgery. We can be hopeful because there is a lot of promise in robotic surgery for beneficial outcomes for patients. While operation times have increased with the use of robotics, the recovery times for patients have decreased. If cost of care can decrease and safety increase, and we find a way to cross the digital divide that separates the use of robotic surgery in the developing world, then robotic surgery will be a welcome addition to the technoscience of surgery.

The prognosis for surgery professionals is also a mixed bag. Some will no doubt receive many financial and academic rewards for their innovative work in bringing more autonomous machines to the operating theatre, but that success may mean that the profession of surgery is not open to as many new practitioners as it was in the past. If we see them only as skilled technicians, then future human surgeons may lose their status as valued professionals.

“...the surgeon must be driven by altruistic motives rather than self-interest. In order for surgeons to maintain their

position as professionals in society, they must not allow the lure of the new and the potential for financial benefit to influence their assessment of whether an innovative procedure truly benefits the patient...the future of surgical innovation is fraught with ethical concerns [22].

Some future ethical concerns that surgeons will have to face in the slightly more distant future will be even more challenging. One would be the surgical implantation of robotic devices into humans. Robotic prosthesis are already on the design board but there are typically wearable items, but soon enough there will be robotic items that will be permanently added to the body. Arguably this has already happened in the mid-sixties with the first artificial heart. Many of the ethical concerns we raised above will be in play here but a new one will be: how ethical is it to enhance the human body? What will a surgeon use to make the decision whether or not to remove a perfectly good appendage to replace it with a robotic one just because the patient wants the increased capabilities of the artificial limb? And we have not even got into the problems with implanting cognitive upgrades in a human mind.

Another amusing, but real problem might occur when a skilled autonomous robotic surgeon with high levels of cognitive skill petitions to join a prestigious medical professional society. Hutan Ashrafian, et al., has proposed that the answer to that might be in subjecting the machine to a modified form of the Turing Test where it would be tested against humans for its skill in diagnosis with other human doctors. They state that:

The application of diagnostic accuracy meta-analytical capability in the context of the modified Turing test leads to two core issues: (a) what are the ethical implications of developing medical diagnostic systems to meet the Turing test and (b) does a patient have a right to know whether or not he/she is consulting a machine or a human practitioner? [31]

These and other issues will have to continue to be monitored.

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